Multi-Function Fluid Measurement System using High-Definition Fiber Optic Sensing, Phase I

Completed Technology Project (2018 - 2019)

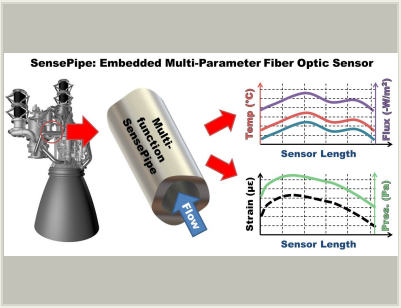
Project Introduction

Propulsion systems require rigorous and highly instrumented testing to enable a comprehensive analysis of performance and to minimize risks associated with space flight. Current testing instrumentation methods can be replaced with embedded sensor systems that are used for monitoring remote, hazardous, or inaccessible locations, while reducing cabling and power consumption. The additional information from the embedded sensor system will enable improved analysis techniques that will accelerate propulsion system developments. Luna proposes to develop a multi-function, drop in, sensor capable of measuring distributed temperature, heat flux, strain, and pressure in metal piping using embedded high-definition fiber optic sensing (HD-FOS). For Phase I, Luna will develop a demonstrator system and structure with an embedded HD-FOS for acquiring multiple physical parameters. The distributed multi-parameter sensor will simultaneously measure multiple physical effects on rocket engine piping and vessels. The HD-FOS has a spatial resolution of 0.65 mm, so thousands of data points can be collected along an optical fiber that can be used to quantify small features on complex test structures depending on the routing of the fiber. The instrumentation is highly flexible for a variety of extreme conditions (e.g. cryogenic) in remote or inaccessible measurement locations. This approach will minimize the wiring associated with multiple independent sensors such as thermocouples and pressure transducers, as well as increase safety benefits inherent in utilizing intrinsically safe sensors in the presence of fuel systems.

Anticipated Benefits

Distributed multi-parameter sensing can benefit existing and future rocket engine and test bed systems to monitor remote or inaccessible piping locations. Distributed sensing in turbojet engine applications in bypass piping, fuel delivery, and turbine coolant channel systems can be used for engine health monitoring. Satellite heat pipe sensing can provide data for cooling and power management. Computational models can leverage high fidelity distributed data for validation purposes.

Many applications extend into existing extreme condition and hazardous industrial processes. The automotive and commercial aircraft industry can use the sensors in critical high temperature components to detect the onset of hardware failure. Distributed sensing in high pressure and temperature fluid systems in nuclear power, oil and gas, and industrial applications can be used to optimize processes and monitor hardware failure in remote or inaccessible locations.



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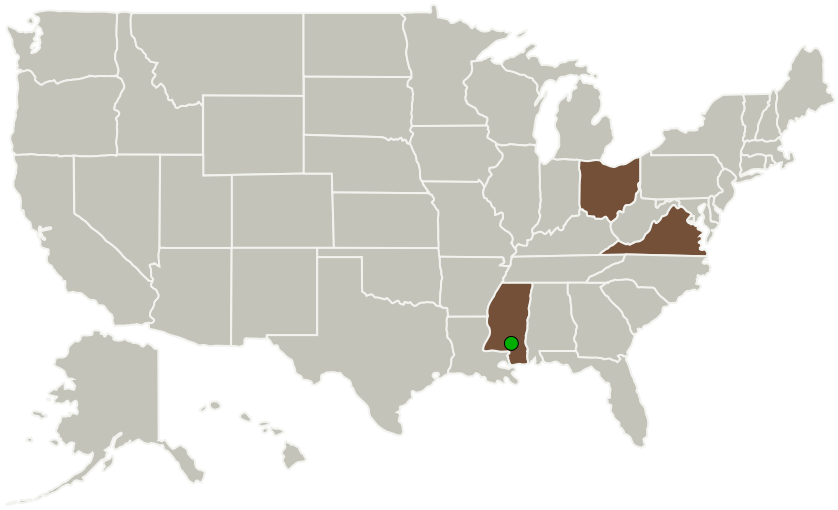
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Luna Innovations, Inc.	Lead Organization	Industry	Roanoke, Virginia
Edison Welding Institute	Supporting Organization	Academia	Columbus, Ohio
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
Mississippi	Ohio
Virginia	

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Luna Innovations, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

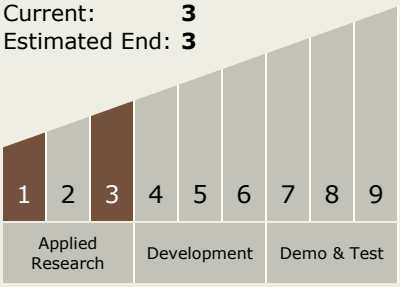
Carlos Torrez

Principal Investigator:

Andrew Boulanger

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



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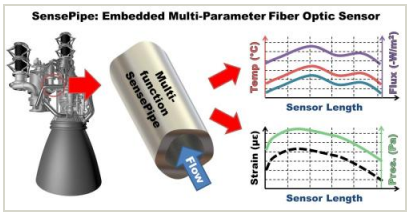
August 2019: Closed out

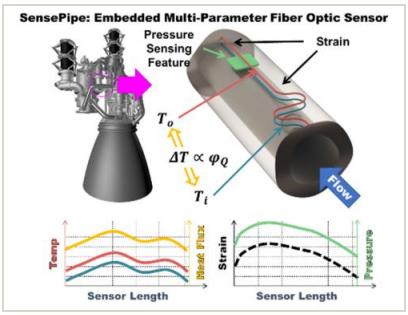
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137866)*

Images



Briefing Chart Image
Multi-Function Fluid Measurement System using High-Definition Fiber Optic Sensing, Phase I *(https://techport.nasa.gov/image/131726)*



Final Summary Chart Image
Multi-Function Fluid Measurement System using High-Definition Fiber Optic Sensing, Phase I *(https://techport.nasa.gov/image/132674)*

Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.4 Mission Success Technologies
    - TX13.4.5 Operations, Health and Maintenance for Ground and Surface Systems

Target Destination

Earth